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The Hon. Bette Stephenson, M.D.
Minister

Curriculum Ideas for Teachers

1978

Geography
Intermediate
Division

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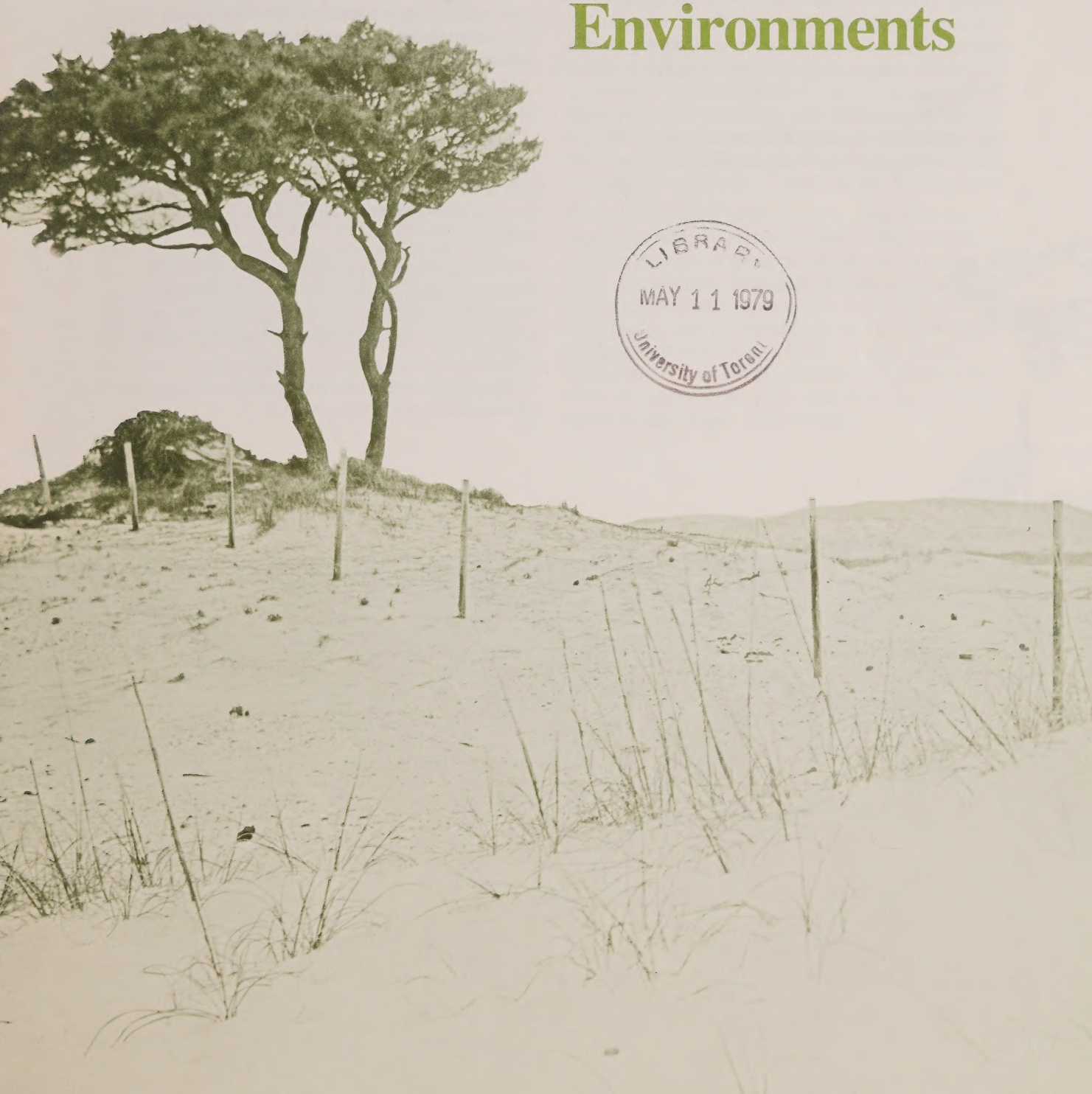
Fragile Environments



Rationale

As outlined in the curriculum guideline *Geography, Intermediate Division, 1977* (pp. 18-19), this unit is designed to illustrate conditions within a number of ecosystems that have been termed "fragile". It is the intention of this unit expansion to give students opportunities to examine a number of such environments scattered across the southern continents. Students will be encouraged to consider the changes that occur within a fragile environment when outside agencies upset the delicate balances that exist there.

The margins of deserts, slopes of mountains, remote islands, and tropical rain forests all possess similar liabilities. Each is an example of a fragile environment whose ability to sustain plant and animal life is extremely vulnerable. Students should be looking at ways in which people can live within these environments. It is not enough that students become familiar with ecological disruptions around the world; they should also become familiar with the problems that people are facing and the solutions that can be offered.

Objectives

This unit on fragile environments will provide students with opportunities to:

– define the term "ecosystem";

– locate examples of fragile environments in the southern continents with respect to their direction and distance from this part of Canada;

– understand relationships among climate, natural vegetation, and animal life in two or more fragile environments;

– consider the positive and negative effects of human activities in those environments;

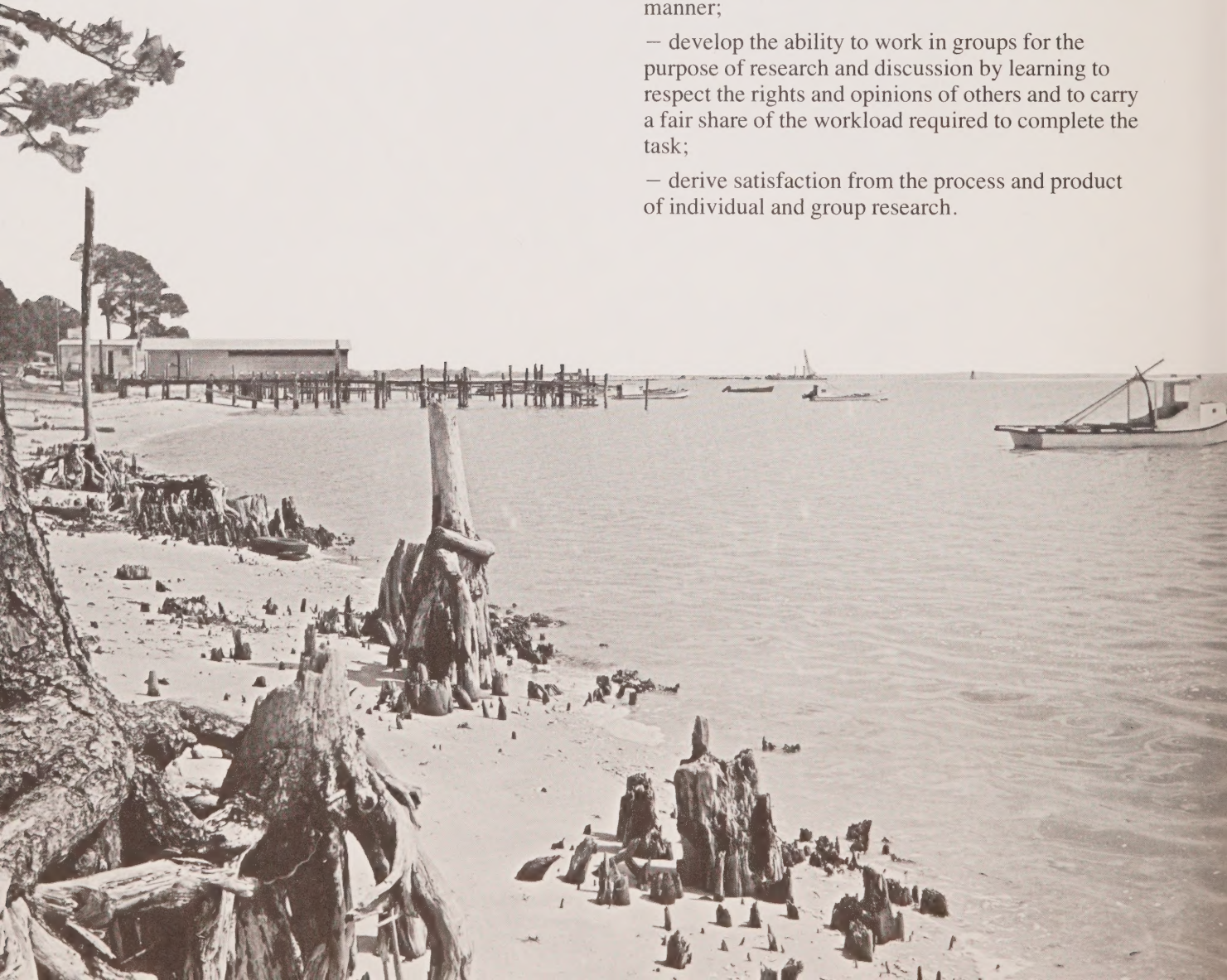
– summarize information taken from a variety of sources in order to make a series of accurate statements about the fragile environments that are found in the southern continents;

– present geographic information accurately and neatly;

– develop individual research skills: defining the task, locating appropriate information, working independently, organizing information in a logical pattern, and presenting information in a succinct manner;

– develop the ability to work in groups for the purpose of research and discussion by learning to respect the rights and opinions of others and to carry a fair share of the workload required to complete the task;

– derive satisfaction from the process and product of individual and group research.



Focus for Study: Organizing Ideas

Studies may be organized around a number of subunits within the theme of fragile environments. While this pamphlet develops only the first two of the following organizing ideas, the remainder may provide further starting points for individual or small-group research projects.

Margins of deserts. A recent study by the United Nations suggests that 36 per cent of the earth's land area can be defined as being extremely arid, arid, or semi-arid. To this figure we should now add another 7 per cent, which represents the total amount of land that has been recently degraded into desert by the human populations that live on the fringes of the desert. It has been estimated that some 60 000 000 people depend for food on the barely arable land at the edges of deserts. Thus, it is in this fringe area, where the sands of the desert are shifting, that the dangerous expansion of the deserts is creating thousands of displaced people and is adding to world food shortages.

Tropical rain forests. Tropical forests are no longer the domain solely of wildlife and native peoples. Because of the increasing world population and the decreasing amount of space available for it, rain forests are being opened up to settlers and to commercial enterprises. It has been estimated that 340 ha of tropical rain forest fall to the axes of the human race in every hour of every day. Rain forests that have remained largely unchanged for millions of years may well disappear in our own lifetimes.

Oceanic islands. Many oceanic islands found in the southern continents are representative of fragile environments with balanced ecosystems in which new human activities may create problems that are difficult to overcome. Because there is little margin for error on islands, what seems like a minor event on a continent can have serious and profound consequences on an oceanic island.

Mountain slopes. Mountain slopes contain many life zones in the range from the lowlands base to the snow line; these life zones represent delicate environmental balances that may suffer irreparable damage from careless human activity.

The oceans. Can the oceans continue to absorb the wastes and poisons that find their way into them? Marine life has dwindled throughout the world, and the careless exploitation of the sea's untapped resources is likely to accelerate that process. What effects will the present plans for mining the ocean floor and for drilling for oil in the oceans have on this fragile environment?

The wetlands. Wetlands are those areas of the world in which land and water meet; they include estuaries, lagoons, mangrove swamps, salt and freshwater bogs, and marshes. Wetlands are shrinking as a result of our need for more space to grow food, to build houses and industrial complexes, and to dump garbage and other wastes. Such systems are often central to the lives of many different creatures; yet it is these areas of ooze, grass, and trees that are being filled to make them "more useful".

Miller Services

Before planning a unit on fragile environments, it is useful to review the relevant pages of the Intermediate Division geography guideline, as set out below, and consider the related suggestions:

– *pp. 3-4:* Review the aims for the geography program for the Intermediate Division and select one or more of them for emphasis within this unit.

– *pp. 4-5:* The individual unit is a part of the year's work in geography. Your responsibility is to see that a balanced set of objectives is reached. Organize the material carefully to ensure that the studies are suited to the interests and capabilities of your students, that the time allocated to the pursuit of a study is consistent with its objectives, and that a variety of methods and viewpoints are employed.

– *pp. 14-16:* These pages list the important items of core content and skill development. Select several of these items for special attention.

– *pp. 18-19:* These pages provide the content base for "Fragile Environments". Note that this pamphlet has chosen two of the topics listed in the guideline as the basis for unit organization.

– *pp. 40-3:* These pages include brief descriptions of the basic elements of geographic studies in the Intermediate Division. Note that the emphasis in this pamphlet is on the "support of life", "people as choosers", and "constant change". The theme of fragile environments can be altered to accommodate other choices.

– *pp. 43-4:* If an ultimate goal of humanity is to live in harmony with the environment, the study of fragile environments should provide opportunities for students to develop informed and rational attitudes about environmental issues.

– *pp. 44-6:* These sections on skills will provide you with a broad base from which you can select what is most useful.

– *pp. 46-7:* The connection between objectives and evaluation is central to the ongoing process of curriculum development.

The evaluation process should be directed towards determining the degree to which course objectives have been achieved. Refer also to *Evaluation of Student Achievement: A Resource Guide for Teachers* (Toronto: Ministry of Education, 1976).

Organizing Idea

The availability of water determines the ability of land to support plant and animal life. On the margins of deserts, periods of drought and heavy losses of moisture through evaporation reduce the capability of the land to support extensive plant, animal, and human populations.

A Content Base

In recent years, deserts in some parts of the world have developed a new public image. More and more people are beginning to think of them as the new "promised lands" of sunshine, clean air, and open spaces. In addition to the wealth of oil that many desert regions produce, agriculture has prospered, thanks to massive irrigation schemes, and tourists are flocking to the new hotels that have been built at many of the oasis regions. This new interest in deserts has created some problems, such as the influx of people into regions where water is scarce, the damage to fragile desert plants, and the speculation of business people.

In that part of Africa known as the Sahel, the Sahara Desert is expanding its range wherever drought, overgrazing, and slash-and-burn land clearing have ruined the adjacent grasslands. Lulled by years of steady rain, the African farmers planted more and more crops and let their herds grow. Then the rains ceased. Crops failed, and cattle became so desperate for food that they stripped their grazing fields of every blade of grass. Goats did the worst damage, as they were able to crop the grass right to the root tops. Eventually, there was only a dusty, barren field where crops once grew. The Sahara had edged southward.

Even though such difficulties may occur in a limited area, they can have wide-ranging effects. What can happen when large amounts of dust enter the atmosphere? Some geographers suggest that such dust can alter the earth's heat balance. The dust particles act like tiny mirrors and reflect some of the sun's rays back into space, thus allowing less heat to reach the earth.

Halting the advance of a desert is no easy matter. One of the main tasks is to teach farmers to limit the number of animals that they keep. But how do you encourage a farmer to raise fewer animals when the region is experiencing hunger or when the number of cattle owned is a sign of wealth? The drilling of deep wells can provide immediate benefits, but may create problems later because of the depletion of underground water supplies. Irrigation schemes, while increasing the area of cultivable land, can lead eventually to excessive mineral concentrations in the soil.

Some progress is being made in the fight against desert expansion. Algeria is mobilizing its young people in a massive tree-planting program all along its 1500 km border. In Egypt, the Aswan Dam has helped to bring into cultivation over 325 000 ha of new agricultural land along the Nile; it is reported that Egypt will double its irrigated land by the year 2000. However, concerned people are asking what the other long-term effects of the dam will be. How long will it be before the reservoir is filled with silt? What will be the effect of the diminished amounts of flood water and silt on the land of the lower Nile and on the Nile delta?

Students who are studying "shifting sands" should work towards understanding the concern for the encroachment of desert sands on adjacent grasslands and for finding methods to protect this fragile environment.

Objectives

Throughout the unit, the students will have many opportunities to:

– understand the relationships among climate, vegetation, and animal life in a desert fringe area such as the Sahel region of Africa;

– consider the positive and negative effects of human activities in the desert regions of the southern continents;

– locate the major desert regions of the southern continents (the Atacama Desert, the Patagonian Desert, the Sahara Desert, the Namib Desert, the Kalahari Desert, and the deserts of Australia) in terms of their direction and distance from the students' own part of Ontario;

– combine information from special-purpose maps, such as temperature, precipitation, and natural-vegetation maps, in order to illustrate new relationships;

– translate statistics and other written information into charts and graphs, such as bar, circle, and climate graphs;

– develop individual research skills, such as defining the task, locating appropriate information, working independently, organizing information in a logical pattern, and presenting information in a succinct manner;

– derive satisfaction from the process and product of individual research.

Teaching Suggestions

– Begin with exercises, such as those on pages 6 and 7, which will lead the students to examine the location and climate characteristics of the deserts.

– Use magazine articles, pictures, films, or filmstrips to find out how plants and animals are adapted to desert conditions.

– Investigate some typical desert food chains.

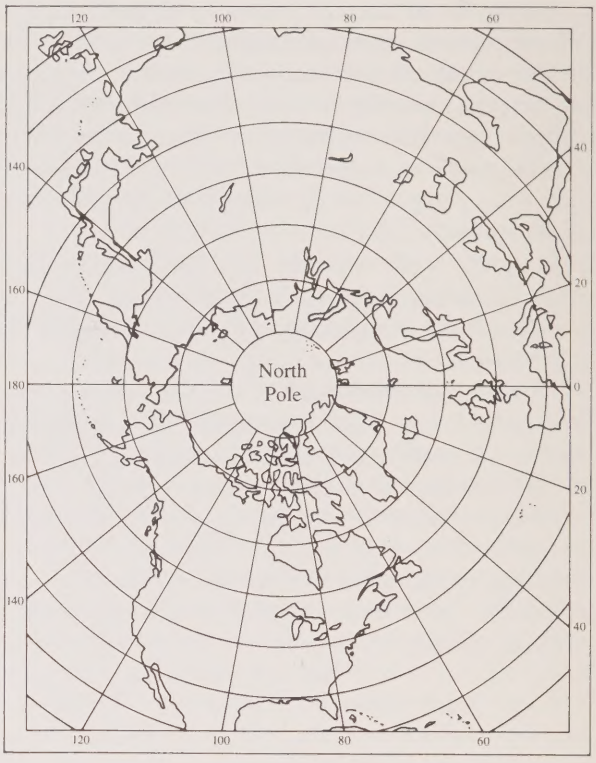
– Have the students consider the reasons for the influx of people into desert regions and the activities that are encouraging a greater use of these areas.

– Discuss with the students what farmers on the fringes of a desert might do when there are a number of years of above-average precipitation, and what might be the results when normal or less-than-normal precipitation patterns return.

– Pose problems for student research, reports, and discussion such as: (a) How can drifting sand dunes be halted? or (b) What can happen when too many animals are grazed in an arid or semi-arid region?

– Have the students examine the characteristics of the ecosystem that is found at the edge of deserts, noting the adaptations of plants and animals to the climate.

Two Map Projections: A Problem in Map Use



1. a) On the *Mercator projection* map of the world:
– choose an appropriate colour and shade in the desert regions. Explain why you selected the colour that you used.
– show the equator by means of a ruled, red line.
– show the tropics of Cancer and Capricorn with broken (- - -), ruled, red lines.

b) Name the desert regions crossed by each of the lines you drew. Make a statement that describes the location of the world's great hot deserts.

2. Colour in the land masses shown in the *polar projection* map. Note how the colour makes the continents stand out.

3. a) Draw a straight line joining the cities of Toronto and Cairo on each of the maps. List the countries over which each line crosses.

b) Why do the routes on each map differ? Which map is better to show the most direct route between the two cities? Use a piece of string and the globe to prove your answer.

c) Would your answer be the same if you travelled by sea? Why?

4. What are the uses of each of the two map projections?

Kano: City at the Edge of the Desert

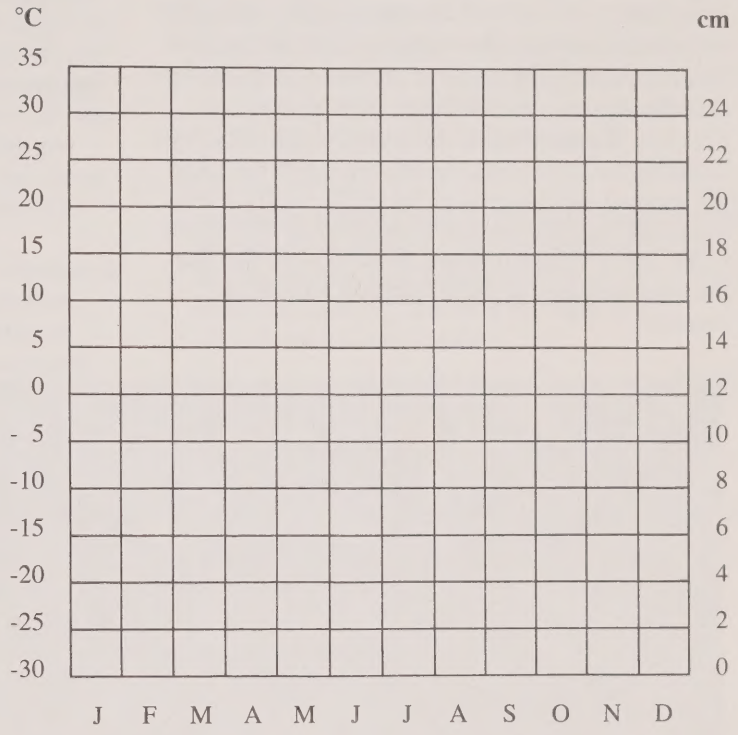
Kano is the principal city of the northern section of Nigeria. It has been an important city for more than a thousand years. For centuries it was one of the main trading centres in Africa, since it was situated within easy reach of the trade coming down the Niger River. It was also at the junction of the two main trans-Sahara caravan routes. More recently, Kano has witnessed a number of devastating droughts.

1. Complete a climate graph for Kano.

Kano: Its Climate

	T	P
January	22°C	0 mm
February	24	0
March	28	3
April	31	13
May	31	64
June	28	114
July	26	203
August	26	313
September	26	140
October	27	13
November	25	0
December	22	0
Year	26°C	863 mm

Kano is located at 12°N at an altitude of 457 m.



2. Complete the following chart:

	Hausa Region	Our Community
Coldest month(s) and its (their) average temperature		
Warmest month(s) and its (their) average temperature		
Number of seasons		
Names of seasons		
Number of months of rapid vegetation growth		

3. What would be the advantages of this climate for agriculture? What problems would it cause a farmer?

Fragile Environments: Tropical Rain Forests

Organizing Idea

Tropical forests are no longer the domain only of wildlife and native peoples. The increasing world population and the decreasing amount of available space have encouraged the opening up of rain forests to settlers and to commercial enterprises – often with drastic results.

A Content Base

A composite satellite photograph of the earth taken a quarter of a century ago would have shown a broad green belt around the equator that was broken only by the oceans. Photographs taken from space today show that the girdle of green has been broken in many places, and has been reduced in area. Pressures from industry, agriculture, and increased populations have made considerable inroads into the tropical rain forest regions of the world. Some scientists hold the view that the tropical rain forest is the world's most threatened ecosystem and that the consequences of its destruction will be far-reaching.

Circling the earth in a band of varying width from the equator outwards to the tropics of Cancer and Capricorn, rain forests cover some 9 000 000 square kilometres – an area about the size of the United States. Few other ecosystems in the world have the diversity of animal and plant life found in tropical rain forests. The dominant fact of life inside this ecosystem is ''rain''. Few tropical rain forests receive less than 2 500 mm of precipitation annually, while totals of 10 000 mm are not uncommon. Air temperatures are always warm in this environment. Temperatures vary little during the year or from day to night. These two factors – abundant rainfall and warm, constant temperatures – are the major determinants of a unique ecosystem.

Miller Services

Students who are studying tropical rain forests should develop an appreciation of the innumerable interrelationships that exist within an environment that at first glance seems far from "fragile". Time should be spent on the anatomy of the rain forest – the emergent layer, the canopy, the middle layer, the shrub layer, the herb layer – and some relationships should be established among these layers and the birds, animals, and reptiles that live in this environment. Students should become familiar with the contradiction between the apparent lushness of the tropical rain forest and its nutrient-poor soil; they should become aware of the fact that the rain forest is a giant recycling centre which puts resources to use as soon as they become available. Perhaps the most astonishing aspect of tropical rain forests is not their wealth of species of plant and animal life, but rather the speed at which the forest uses its basic resources of water, heat, minerals, and organic material.

The list of inroads into this fragile environment is endless. It includes the new settlement schemes underway in Amazonia with the introduction of some 18 000 000 farmers and industrial workers; the new chip-board factories in places as far apart as New Guinea and the Choco rain forests of Colombia; and the thousands of small farmers who practise a slash-and-burn type of agriculture as did their forefathers for generations, but who do not have the luxury of being able to move to a new region when the soil nutrients have been depleted. Similar examples will lead students to a better understanding of the consequences of unwise human activity in this part of our world.

Objectives

Throughout the unit, students will have many opportunities to:

– locate the major tropical rain forests of the world in terms of latitude, continental location, distance and direction from their own part of Ontario;

– define terms associated with tropical rain forests, including "selva", "canopy", "buttress", "fungi", "liana", "emergent", "leaching", "laterite", "convectional rainfall", and "ecosystem";

– investigate the interrelationships that exist in the tropical rain forest ecosystem among precipitation and temperature and natural vegetation; the interrelationships among the various layers of the rain forest and the birds, animals, and reptiles found within them; and the factors that make up the nearly closed system that permits the forest to recycle its resources;

– outline the reasons why tropical rain forests are considered "fragile";

– hypothesize about the long-term effects of the loss of sizeable portions of the world's tropical rain forests;

– develop the ability to work in groups for purposes of research and discussion by learning to respect the rights and opinions of others and to carry a fair share of the workload required to complete the task.

Teaching Suggestions

– Begin the study with a series of pictures that illustrate the lushness of the tropical rain forest environment. Place the following quotation from Tom Kimball, Executive Vice-President of the National Wildlife Federation, before the students:

> The tropical rain forest is by far the world's most threatened ecosystem. The consequences of all the destruction now taking place may be far more costly to man over the long run than any short-term economic gains.

Let the quotation form the basis for inquiry: What? Where? Why? Who? How?

– Plan activities using films, filmstrips, and seatwork exercises that will provide students with a good understanding of the interrelationships that are found within the ecosystem.

– Consider individual or small-group research projects on other fragile environments in conjunction with the study of tropical rain forests.

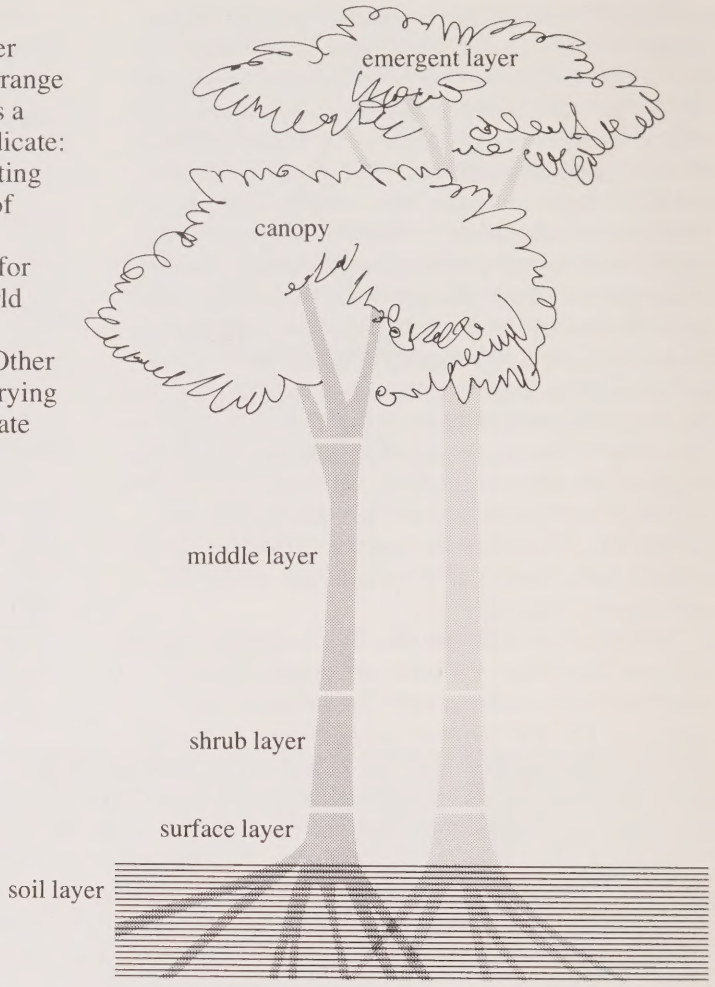
– Provide the time and space for a creative reporting of the findings of the groups. Mobiles, bulletin-board displays, and panel discussions are three examples of activities that provide a clear indication to the group that the job is completed.

– Try activities such as the following. Be sure that there is adequate resource material available before asking your students to do any research assignment.

Make a Mobile

The tropical rain forest is made up of five rather distinct layers – six, if we include the soil. Arrange the mobile in a shape that somewhat resembles a large tree. Each panel of the mobile should indicate: (a) the physical factors that are at work in creating the specific layer; and (b) the results in terms of vegetation and animal life.

Information on the emergent-layer section, for example, could include a climate graph, a world map showing rain forest locations, and aerial photographs of a typical forest in the tropics. Other panels will tell how the vegetation reacts to varying amounts of sunlight and rainfall and will indicate the animal life found in that section.



What Can Be Learned From a Diurnalgraph?

1. Locate the city of Manaus on the accompanying map.

2. Plot the daily maximum temperatures in the centre of each daily square on the graph; join the dots with a red line.

3. Plot the daily minimum temperatures on the vertical lines separating the days; join the dots with a blue line.

4. Shade in the area found between the maximum and minimum lines; this is the *daily range of temperature*. Use a colour that will best describe the temperature (dark red? light red? light blue?).

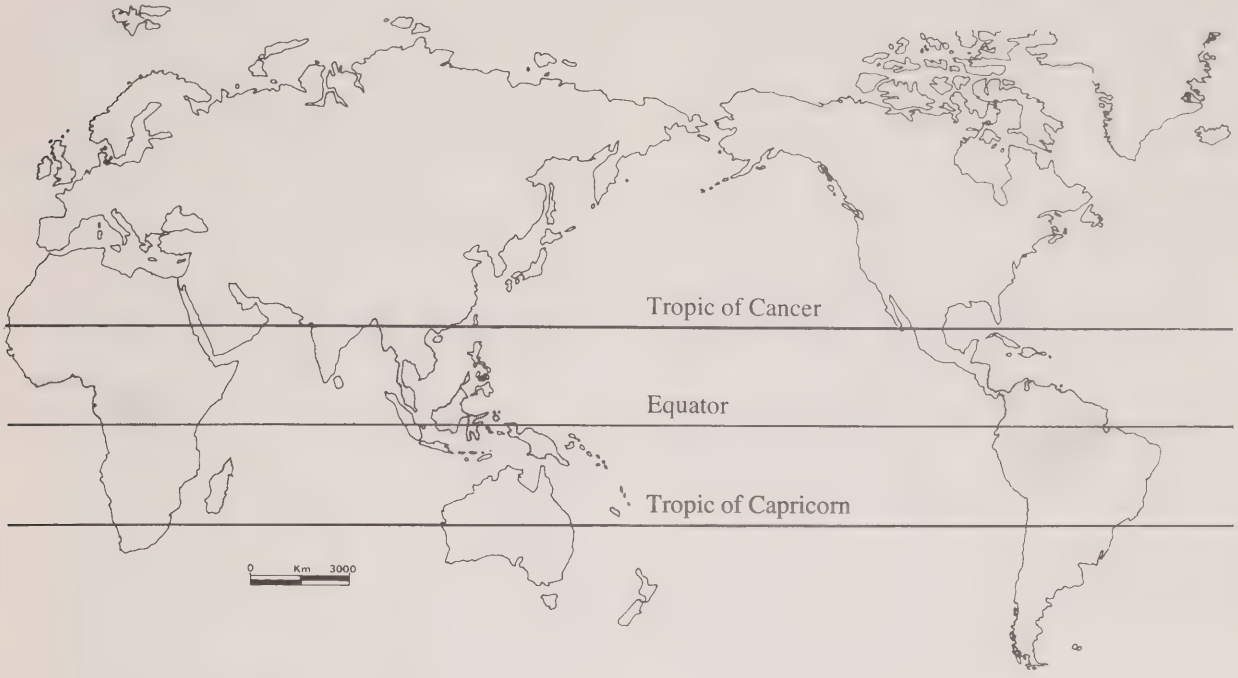
5. What does the diurnalgraph tell you about growing conditions at Manaus in January? What additional information do you need before you can draw conclusions about growing conditions in January?

6. What additional information do you need to reach conclusions about the growing conditions for the whole year?

7. Use an atlas to learn more about the climatic pattern at Manaus for a full year.

8. From this information, what statements could you make about this ecosystem's natural vegetation and animal life? About the agricultural products that might be grown there?

Tropical Rain Forest Regions

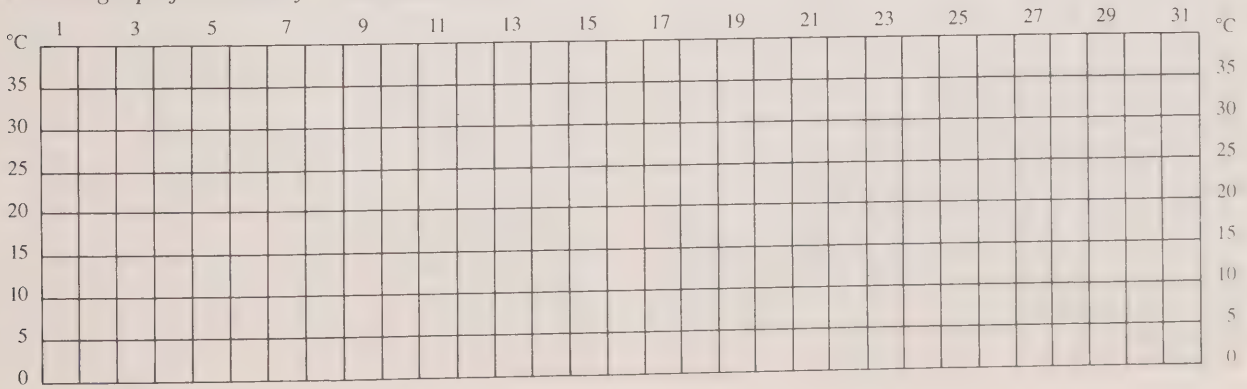


A Typical January at Manaus, Brazil

Maximum and Minimum Daily Temperatures

Jan.	*Max.*	*Min.*	*Jan.*	*Max.*	*Min.*
1	34°C	24°C	17	35°C	24°C
2	33	24	18	34	25
3	33	22	19	35	26
4	32	22	20	34	26
5	32	22	21	35	26
6	34	23	22	34	25
7	34	23	23	35	24
8	32	21	24	34	24
9	33	24	25	35	22
10	34	24	26	34	25
11	34	23	27	31	24
12	33	24	28	35	24
13	33	23	29	31	24
14	34	23	30	35	25
15	33	23	31	33	24
16	33	24			

Diurnalgraph for January – Manaus, Brazil



Tropical Rain Forests: A Research Assignment

Find the answers to each of the following questions and place the letter identifying the best answer in the space provided.

1. ____ A synonym for ''tropical rain forest'' is:
(a) selva; (b) jungle; (c) ecosystem; (d) taiga.

2. ____ Low-lying equatorial regions are always hot because:
(a) the humid air does not allow heat to escape; (b) the sun's rays are always direct; (c) they have long hours of sunshine; (d) the dark surface of the forest absorbs heat.

3. ____ Temperatures in tropical rain forest regions:
(a) never drop below 35°C; (b) never average below 25°C; (c) show a great range; (d) are much cooler during the month of January than during July.

4. ____ Annual precipitation in a tropical rain forest region ranges between:
(a) 100 and 1 000 mm; (b) 1 000 and 2 000 mm; (c) 3 000 and 10 000 mm; (d) 2 500 and 5 000 cm.

5. ____ Many large trees in tropical rain forests have:
(a) flared or buttressed roots; (b) deep tap roots; (c) the ability to conserve moisture; (d) needle-like leaves.

6. ____ One of the common features of the tropical rain forest is the ''lianas'', which are:
(a) brightly coloured birds; (b) large burrowing insects; (c) climbing plants; (d) animals that feed on termites.

7. ____ ''Epiphytes'' are plants that:
(a) have extremely large leaves; (b) cover the forest floor; (c) develop dark-green, leathery leaves; (d) grow attached to the branches of other trees.

8. ____ In a tropical rain forest you would not expect to find:
(a) teak; (b) mahogany; (c) boabab; (d) sandalwood trees.

9. ____ A ''piranha'' is a dangerous:
(a) fish; (b) bird; (c) animal; (d) reptile that is found in the tropical rain forests.

10. ____ You would most likely find a ''sloth'' in:
(a) a water hole; (b) a river; (c) a burrow; (d) a tree.

11. ____ The anaconda is an interesting:
(a) mammal; (b) reptile; (c) fish; (d) fern-like plant.

12. ____ In a tropical rain forest you would not expect to find:
(a) a gnu; (b) a macaw; (c) a tapir; (d) a jaguar.

13. ____ Rain forest soils are said to be ''leached'' because:
(a) they are infertile; (b) there is laterite present; (c) they are deep; (d) soluble minerals have been removed.

14. ____ Rain forest soils are called ''laterites'' because:
(a) the heavy rains wash them away; (b) they contain much insoluble iron oxide; (c) they lack humus; (d) they are extremely fertile.

15. ____ ''Leaching'' occurs because:
(a) farming techniques in the tropics are poor; (b) very little fertilizer is used; (c) heavy rains cause a downward movement of minerals through the soil; (d) there is little in the way of insoluble minerals in the soil.

16. ____ Which of the following is *least* representative of the tropical rain forest?
(a) dense underbrush; (b) a large number of species of trees; (c) many vines; (d) flared or buttressed tree bases.

Research Hints

Here are some hints for improving the standard of work done by your students.

Assembling Resources

International Wildlife magazine published a series of articles entitled "This Fragile Earth" beginning with the July-August 1976 issue and concluding with the May-June 1977 issue. You will find these articles to be a most useful source of information.

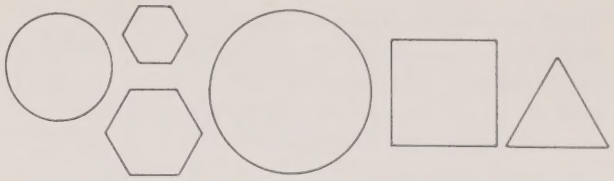
The *Geographical Magazine* – June 1975, May 1977, July 1977, September 1977, November 1977, December 1977 – contains articles which provide excellent resource material for this unit.

The physical geography textbooks used in secondary schools contain chapters on tropical rain forests, oceanic islands, volcanic activity, climate, and weather. Copies of several of these books may be available or may be considered for purchase.

Articles pertaining to the quality of the environment appear frequently in many newspapers and magazines. Such items should be cut out, mounted on Bristol board that has been cut to a standard size, and laminated. Over a period of time, a wealth of resource material can be accumulated in this way.

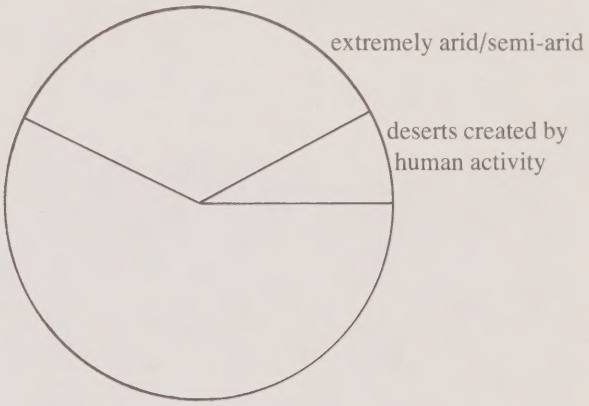
Mapping

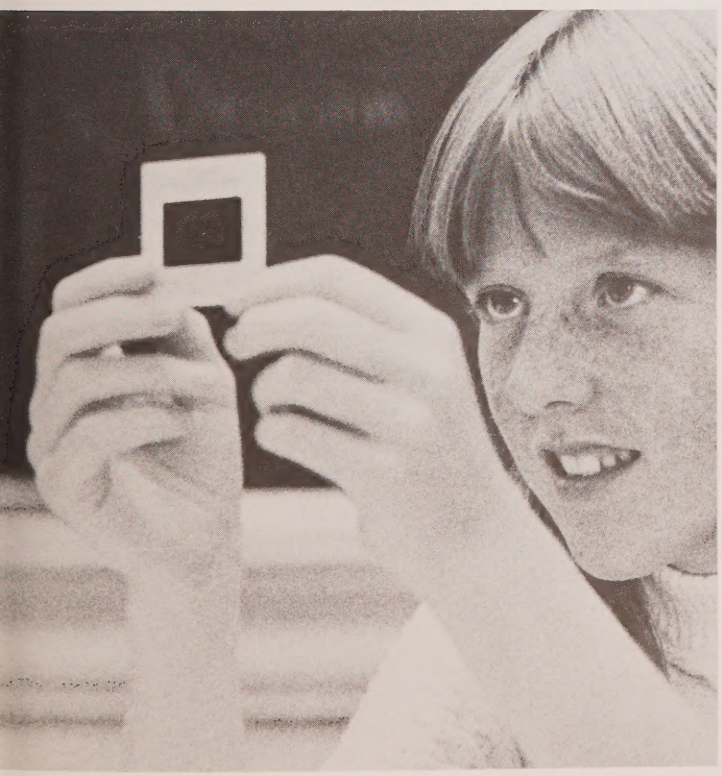
Do your students use templates? Most bookstores, especially those associated with universities, sell a wide range of templates. Good standards of mapping are more easily attained when proper equipment is used.

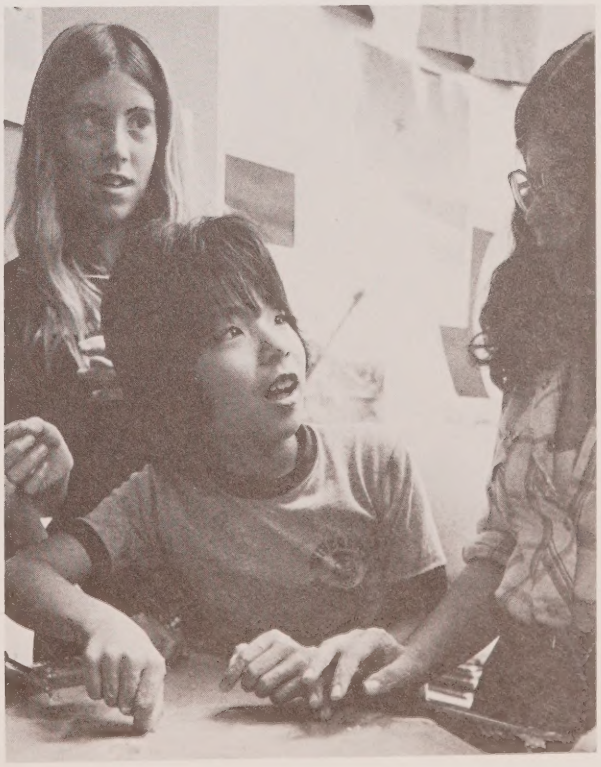


Graphing

The section in this unit entitled "Shifting Sands" points out that 36 per cent of the earth's land surface may be classified as extremely arid, arid, or semi-arid, and that human activity has accounted for an additional 7 per cent of desert-like land. This information becomes more meaningful when it is translated into graphic form.

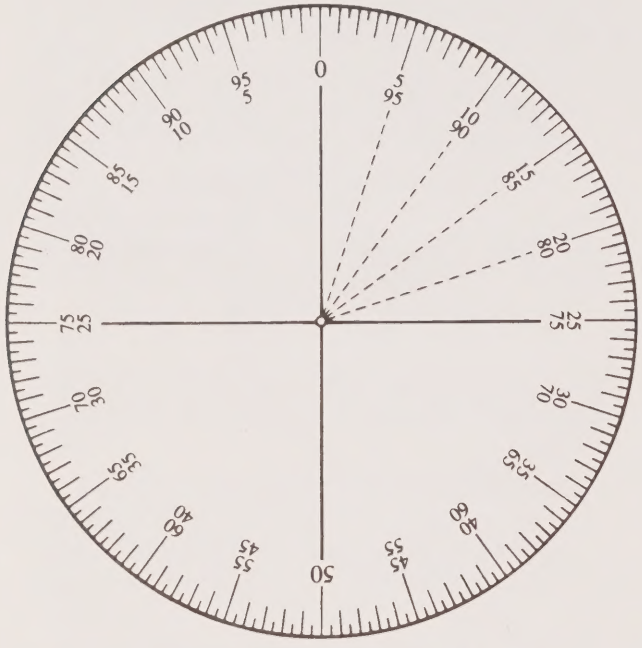






The percentage protractor reduces the amount of time needed to complete a circle graph such as the one on page 13. The figures 36 per cent and 7 per cent are read directly from the protractor, thus eliminating the laborious process of converting percentages to degrees and then using a conventional protractor. Alternatively, a class might invest some time completing a permanent list of conversions, for example:

1% = 3.6 or 4°
2% = 7.2 or 7°
99% = 356.4 or 356°



Interpreting Climate Graphs

Words such as hot, cold, cool, dry, and wet are very much a part of our vocabulary when we discuss information that pertains to weather and climate. Many of these terms have very precise meanings, as the following tables reveal.

Table 1:
Monthly Average Temperatures

Degrees C	Description
+30	very hot
20 to 30	hot
10 to 20	warm
0 to 10	cool
−10 to 0	cold
under −10	very cold

Table 2:
Annual Range of Temperature

Degrees C	Description
below 5	small
5 to 15	moderate
15 to 30	large
above 30	very large

Table 3:
Annual Average Precipitation

Hot to very hot climates	Description of amount	Warm to cold climates
below 375 mm	slight	below 250 mm
375 to 625 mm	small	250 to 500 mm
625 to 1125 mm	adequate	500 to 1000 mm
1125 to 1750 mm	large	1000 to 1500 mm
above 1750 mm	very large	above 1500 mm

Table 4:
Monthly Average Precipitation

Amount	Description
below 50 mm	dry month
50 to 150 mm	wet month
above 150 mm	very wet month

Note: The effectiveness of the rainfall that a region receives depends a great deal on temperatures, because evaporation may remove much of the moisture that plants and people require. For this reason descriptions for precipitation vary with the temperature: precipitation in a hot climate must be higher than in a cold climate before it can be classified as very large. We must consider what is available to plants *after* evaporation.

Table 5:
Distribution of Precipitation

Summer maximum	Over 60 per cent falls during the six warmest months.
Winter maximum	Over 60 per cent falls during the six coldest months.
Evenly distributed	No summer or winter maximum

Thus, if we wish to describe the climate of Manaus from these statistics, we can do so as follows:

Manaus, Brazil (elevation 45 m)

	T	P
January	27°C	249 mm
February	27	231
March	27	262
April	27	221
May	27	170
June	27	84
July	27	58
August	28	38
September	28	46
October	28	107
November	28	142
December	27	203
Year	27°C	1811 mm

We can say that Manaus:

– has twelve months of ''hot'' temperatures (Table 1);

– has a ''small'' temperature range (Table 2);

– receives a ''very large'' amount of precipitation (Table 3);

– has six months that are ''very wet'', four months that are ''wet'', and two months that are ''dry'' (Table 4);

– has seasonal precipitation: there is a wet season and a dry season (combination of Table 5 and reasoning).

We can then deduce that:

– the natural vegetation of the region of Manaus is tropical rain forest;

– the soils of the area will be heavily leached.

Planning a Project

Student achievement on a unit of work as outlined in this support material could well be evaluated by assigning a project that is clearly related to the stated objectives and to the learning experiences provided. Be careful of the following problems that are associated with projects:

– the great variation in student effort, interest, ability, and output;

– the lack of resources for a large number of students;

– the lengthy time taken up in the reporting stage.

There are no pat answers to these and other problems, but it helps if students know exactly what the job consists of and *when the job is finished*.

Let us use the Galapagos tortoises as our example.

1. Ask a small group of students to:

– prepare a map to show the route that could be used to reach the Galapagos Islands from their part of Ontario;

– draw up a résumé, using airline schedules and tourist literature, to show how that part of the world can be reached from Ontario, where a visitor can stay, and the modes of transportation that can be used to go there;

– complete a climate graph that will provide information about the islands;

– provide a large-scale map of the island group showing points of interest.

2. Use a ''baker's dozen'' technique in your instructions, as follows:

– List *thirteen* items of information that everyone should know about the Galapagos tortoises. Write one sentence about each item.

– Select *three* of the thirteen items and write an additional two or three sentences indicating why they are of more importance than the others.

– Write a paragraph about the *one* item that seems to be the most interesting or important.

3. Give additional direction in terms of time, for example:

– The project is to be completed and handed in four weeks from ''today''.

– You will be given six class periods to work on the project: January 11, 13, 18, 20, 24, 27.

– A progress report is due on January 12 and 21.

The stage is now set for work; the students know exactly what is expected of them.

Miller Services

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